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(54) An industrial robot

(57) A device in an industrial robot for control of cabling 12, said cabling comprising a plurality of cores. The cabling is arranged to be pulled through a first and a second robot part 100, 101, 103, 105, 104, 106, 107, 108, said robot parts being movably arranged for both rotation and bending relative to one another. The device comprises a casing 3a surrounding the cabling, and a first control member (50) arranged at one end of the casing, a second control member (40) arranged at the other end of the casing, wherein said control members being designed to fix the cores included in the cabling in a radial direction, so that the cores extending through the control members and the casing are subjected to bending only. A corresponding method is also defined.

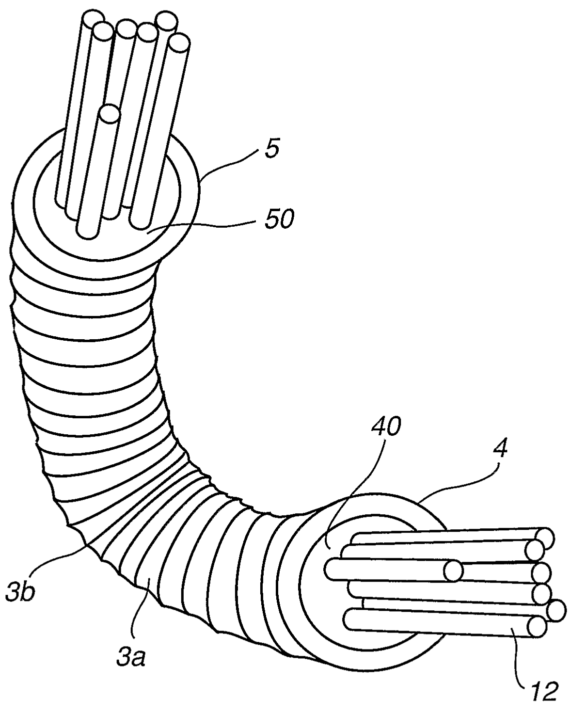

Fig. 4

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Description

TECHNICAL FIELD

[0001] The present invention relates to an industrial robot. More precisely, the invention relates to a device in a wrist housing for a robot arm in such an industrial robot. The robot arm comprises a wrist comprising a turn disc which, in turn, comprises a toolholder. The turn disc is rotatable relative to the wrist. The toolholder is adapted for attachment of a tool. When attaching a tool to the toolholder, cabling is arranged to the tool. The invention relates particularly to a protective device for the cabling.

BACKGROUND ART

[0002] An industrial robot is composed of interconnected robot parts such as, for example, a stand, robot arms, an arm housing, a wrist and a turn disc. Two adjoining robot parts are connected to each other so as to be rotatable in relation to each other around an axis of rotation, or are linearly displaceable in relation to each other.

[0003] The cabling is here primarily intended to comprise process cabling. Cabling may also be intended to comprise power supply for driving motors that drive the rotational movements of the robot. Cabling may also comprise control cabling for controlling the robot. In addition to this, cabling may also comprise spare circuits for the specific needs of the customer.

[0004] Process cabling is here intended to comprise cables for power and signals, conduits for fluids and gases, and sometimes also an empty bendable protective casing, which is arranged for future laying of one or more conduits and cables. Process cabling transports process media, such as electricity, water and air, to the tool. Process cabling is space-demanding and stiff.

[0005] The outer arm of an industrial robot must often pass through narrow passages and work in narrow spaces. When utilizing welding robots, for example, it is common for the process cabling to be pulled outside of the robot. For welding operations in, for example, the car industry, the robot must reach into narrow spaces in a car body to perform welding. If the process cabling then runs freely outside the robot, there is a risk of the cabling getting hooked up in structural parts of the car body, especially where the process cabling runs unprotected around the wrist and the tool of the robot. Hooking of the cabling in turn leads to damage to the cabling and unintentional service interruption, which has an injurious effect on the production.

[0006] Problems arise when the work to be carried out by the robot requires that robot parts articulately connected to one another simultaneously rotate and bend relative to one another. Cabling connected to the industrial robot and disposed so that it passes said robot parts will then be subjected to a simultaneous rotation and bending. During simultaneous bending and rotation of cabling, the individual lines are subjected to elastic elongation and torsion. Since the robot moves in repetitive cycles, this takes place all the time at the same locations in the cabling. Cabling offers great resistance to simultaneous rotation about two axes perpendicular to each other. This results in mechanical stresses on the cabling, which increases the risk of fatigue breakdown of the cabling. The mechanical stresses may also lead to breaking of the individual lines and cables in the cabling. The individual lines and cables are made of different materials depending on their function. In positions where the elongation and the torsion of the cabling is considerable, undesired wear on the individual lines and cables occurs as well. The service life of the individual lines and cables is thus dependent partly on their geometrical location in the cabling.

[0007] It is thus desirable to protect cabling from fatigue breakdown. The cabling is subjected to elongation and torsion in connection with the repetitive movements of the robot. The cabling should withstand the stresses occurring on the cabling upon the movements arising when the cabling is disposed with respect to passage past one of the axes of the robot.

[0008] WO 00/37224 describes an industrial robot with a robot arm. From this publication it is known to place control means for controlling cabling internally of a robot arm. The cabling is disposed extending through a protective casing in the form of a bellows. The object is to accommodate cabling in a compact and space-saving manner, and protected from fouling. However, a bellows is sensitive to stresses, especially if the bellows is subjected to stresses from shearing forces that arise if subjected to torsional movements.

[0009] US 4,499,784 describes an industrial robot with a robot arm comprising a turn disc with a tool. From this publication it is known to arrange cabling internally of a wrist housing. The object is to achieve a robot wrist with a rounded shape. However, also in this case, a bellows is utilized to house cabling for the purpose of rotating the turn disc. This is an unwieldy solution that is not suitable for precision work. To transmit a sufficient torque to the turn disc, the bellows must be given a large dimension, and the wall of the bellows must be given a strong cross section, which makes the bellows stiff and inelastic and, in addition, bulky. In addition to this, a bellows is cost-demanding since it is more expensive to manufacture and must be replaced more often.

[0010] It is desirable, among other things because of the expense, to provide an industrial robot in which cabling is arranged in a compact/space-saving and protected manner. An additional wish is to arrange the cabling so that it can be bent and rotated a large number of times in a controlled manner without being subjected to unreasonable wear.

[0011] In the robot industry, in industrial robots with a large mobility of the tool, there is thus a need to arrange the cabling inside the robot in a way that provides a long service life for cabling which is subjected to frequent simultaneous elongation and torsion.

SUMMARY OF THE INVENTION

[0012] It is an object of the invention to provide a device in an industrial robot intended to protect cabling, which device causes a gentle load on cabling and hence extends the life of the cabling. It is a further object to transmit a rotational movement between robot parts independently of the fact that the robot parts at the same time bend relative to one another.

[0013] According to the invention, these objects are achieved by a device that exhibits the characteristic features described in the characterizing portion of claim 1, and by a method that exhibits the features described in the characterizing portion of claim 11, and by an industrial robot that exhibits the features described in the characterizing portion of claim 10.

[0014] The solution according to the invention is to provide a device for controlling cabling with a torsionally rigid casing between the robot parts, and to stabilize said casing by providing the device with armouring as well. This combination results in the device constituting a torque transmitter that is capable of transmitting a rotating torque while at the same time being subjected to considerable bending.

[0015] The device is arranged in an industrial robot for controling cabling comprising a plurality of cores. The cabling is pulled through a first and a second robot part. The robot parts are movably arranged for both rotation and bending relative to each other. The device comprises a casing surrounding the cabling. The device comprises a first control member arranged at one end of the casing and a second control member arranged at the other end of the casing. The control members are adapted to fix the cores included in the cabling in a radial direction. Armouring the casing between the control members is designed to essentially preserve the cross section of the casing upon a relative movement of the robot parts. The casing and the armouring are adapted, upon relative movement of the robot parts, to cooperate to convert a rotation of the first control member into synchronous rotation of the second control member. In this way, the cores extending through the control members and the casing are subjected to bending only.

[0016] The device is arranged in a torsionally rigid manner by reinforcing the casing with armouring. Since the device is torsionally rigid, it is suitable for transmitting a rotation from one end to the other end thereof. The device converts, essentially synchronously, a rotation of the first control member into synchronous rotation of the second control member. The device thus transmits a torque from the first control member to the second control member.

[0017] The cabling is disposed so as to extend through each of the two control members. As a result of this, the cabling is fixed radially while at the same time it is longitudinally movable. In this way, the rotational movements of the cabling are distributed from the first control member to the second control member. It is part of the inventive concept that lines and cables included in the cabling are arranged essentially symmetrically next to each other through each of the control members or with some other orientation that facilitates the rotational movement. When the cabling is alternately bent and stretched, changes in length occur, but since the cabling and the individual cables and lines are allowed to move longitudinally within the casing, they will accompany the casing in its movements. During this combined rotational movement and bending movement, the rotational movement and the bending movement are divided across the cabling. A first part of the cabling, which is inside the device, is subjected to the bending movement. A second part of the cabling, which is outside the device, is then subjected to the rotational movement. The rotating movement is often carried out at a high velocity, which means that the individual parts of the cabling must be flexible relative to one another. In addition, the cabling is often extensive, which requires a structured location. It may also occur that individual cables have a large diameter. The service life of the cabling increases when the cabling is treated in a gentle manner with torque relief. Cabling in an industrial robot may offer considerable rotational resistance, which means that large shearing forces are created.

[0018] By the term flexible is meant here that the casing is elastic in its longitudinal direction in such a way that the diameter and cross section of the casing is essentially shape permanent. The inside of the casing is preferably even and smooth.

[0019] In a preferred embodiment of the invention, said armouring comprises a helical spring. A spiral is acting in the same direction as the shear forces when rotating the spiral in one direction, which results in a tensile stress. When rotating the spiral in the other direction, the shear forces are acting to reduce the spiral diameter of the spiral, which results in compressive stress.

[0020] In another embodiment of the invention, the helical spring is cast into the flexible casing, as an armouring of the casing. In this way, a stabilized helical spring is resistant to deformation and retains its circumference, the spiral diameter, upon simultaneous rotation and bending about two axes. The helical spring is prevented from expanding and contracting, respectively, upon torsional load by the flexible casing preventing the movement. During bending, the flexibility of the casing causes it to absorb the small changes in length that occur between, respectively, the inner and outer radius of curvature of the helical spring. Since the helical spring is part of an armouring of the casing, the helical spring essentially retains its location relative to itself in the casing during the combined rotational movement and bending movement.

[0021] In a further embodiment of the invention, said device essentially retains its cross section during simultaneous bending and rotation. This means that the device is shape permanent both when being subjected to subatmospheric pressure and to overpressure.

[0022] In still another advantageous embodiment, said first robot part comprises a turn disc. When the robot is working, the turn disc is rotating. This means that cabling connected to the turn disc, such as process cabling, accompanies the wrist during rotation thereof about the centre axis of the wrist. The first control member is connected to the turn disc and the second control member is disposed in the first robot arm. Further, the casing is also arranged to extend through the wrist housing. Transmission of torque takes place from the first control member to the second control member. The second control member is rotatably arranged about the centre axis of the robot arm but fixed to a given interface of the first robot arm. The torque transmission occurs from the turn disc and backwards into the robot arm. The device according to the invention converts the rotating torque from the turn disc past the bending of the wrist into a rotation of the second control member inside the robot arm. The casing converts the rotation of the turn disc into a rotation of the second control member. That part of the cabling that is between the turn disc and the robot arm, in the wrist housing, is subjected to the rotational movement. The other part of the cabling that is inside the robot arm, before the wrist housing viewed from the power source, is subjected to the rotational movement. The design makes possible a bending of the wrist that exceeds a perpendicular bending.

[0023] In an alternative embodiment according to the preceding embodiment, the second control member is rotatably arranged about the centre axis of the wrist housing, but is able to move along a limited section of the first robot arm between two stop positions in the form of, for example, pins.

[0024] In yet another preferred embodiment of the invention, said first robot part comprises a foot.

[0025] In still another preferred embodiment of the invention, said control members are detachably arranged.

[0026] In a still further preferred embodiment of the invention, the casing includes a fold between helical turns formed from the armouring. This increases the mobility of the casing.

[0027] In an additional preferred embodiment of the invention, the rotation is transmitted by means of shear forces.

[0028] A casing of a stiff material that withstands the transmission of torque does not manage at the same time to be bent without being greatly deformed. A single helical spring without a casing is not sufficiently torsionally rigid to manage to transmit a sufficient torque. Nor does a casing of a soft flexible material that withstands being bent in the manner described above, for example a hose, manage to transmit sufficient torque. In addition, a soft material without armouring has a considerably shorter service life when being subjected to torque than a material with armouring. The softer the material, the more asynchronous the rotational movement, until the casing finally collapses. Because the casing is armoured, it becomes more resistant. Because the casing is armoured, it also becomes more rigid with respect to torsion. In addition, a casing with armouring also becomes essentially shape permanent. The armouring preferably extends through the casing.

[0029] A bellows consists of folded sections of a thin material distended by thin units of an essentially circular or rectangular shape of a hard material, said units being formed with alternately small and large diameters. A bellows consists of a thin material. A bellows is designed to take up longitudinal differences. The bellows bursts if one end thereof is twisted in relation to the other end while at the same time being stretched. If the torsional movement is too large, the bellows will collapse.

[0030] In a device according to the invention, the flexible material is arranged to be torsionally rigid by casting an armouring, such as a torsion spring, into the casing. This stabilizes the casing and prevents collapsing thereof. The device is hence capable of transmitting a torque. A helical spring cast into a flexible casing hence transmits a larger torsional moment than a bellows.

[0031] One advantage of placing the cabling in a casing, comprising a helical spring, is that the casing may be made transparent, which simplifies ocular inspection of the cabling.

[0032] Still another advantage of an internal location of the cabling inside a casing is that this is a space-saving solution.

[0033] Advantageous further developments of the invention will become clear from the following description and claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] The invention will be explained in greater detail, by description of embodiments, with reference to the accompanying drawings, wherein:

Figure 1	is an industrial robot according to the state of the art,
Figure 2	is a preferred embodiment of a device according to the invention,
Figure 3	is a wrist housing comprising a device according to the invention,
Figure 4	is the above-mentioned embodiment of a device according to the invention, comprising cabling, and
Figure 5	is an industrial robot comprising a preferred embodiment of a device according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0035] The following description relates both to the method and to the device.

[0036] Figure 1 shows an embodiment of an industrial robot according to the prior art. The industrial robot comprises a foot 100, a stand 101, a first robot arm 103, a second robot arm 104, an arm housing 105, a wrist housing 106, a wrist 107, and a turn disc 108.

[0037] The foot 100 of the industrial robot is stationarily mounted to a base. The foot supports the stand 101, which is rotatably arranged in relation to the foot about a first axis Ax1. The stand supports the first robot arm 103. The first robot arm is rotatable in relation to the stand about a second axis Ax2. The first robot arm supports the arm housing 105. The arm housing is rotatable in relation to the first robot arm about a third axis Ax3. The arm housing supports the second robot arm 104. The second robot arm is rotatable in relation to the arm housing about a fourth axis Ax4, which coincides with the longitudinal axis of the second robot arm. The second robot arm comprises the wrist housing 106. The wrist housing supports the wrist 107. The wrist is rotatable in relation to the wrist housing about a fifth axis Ax5. The wrist supports the turn disc 108, which is rotatably arranged about a sixth axis Ax6. The turn disc comprises a toolholder. The toolholder is adapted for attachment of a tool.

[0038] Figure 2 shows an exploded view of a preferred embodiment of a device according to the invention, comprising a casing 3a with a through passage. The casing comprises a first control member 50 and a second control member 40, which are concealed in the figure, as well as a first fastening device 4 and a second fastening device 5. The casing 3a comprises armouring 3b, such as a helical spring in this case. The casing is adapted to receive and accommodate continuous cabling. The helical spring has an outer radius of curvature Ro and an inner radius of curvature Ri.

[0039] Figure 3 shows an exploded view of a preferred embodiment of a device according to the invention, a wrist housing 106 arranged to the outer part of a second hollow robot arm in an industrial robot of the type described above, a wrist 107, a turn disc 108, a first control member 50, a second control member 40, and cabling 12. The casing has been removed for the purpose of exposing the cabling.

[0040] The wrist housing 106 supports the wrist 107. The wrist supports the turn disc 108. In the hollow second robot arm which is rotatable about its longitudinal axis, the cabling is arranged internally of the robot arm, extending through the first control member 50 and the second control member 40. In this case, the cabling is process cabling. In the wrist housing, said process cabling is arranged internally through the centre axis of the wrist. In addition, the process cabling is arranged to be fixed to the turn disc and to the remote end of the upper robot arm (not shown), which end is supported by the first robot arm.

[0041] The first control member is arranged at the turn disc 108 and accompanies the disc during rotation. The second control member is rotatably arranged at the first robot arm 103 about the centre axis of the robot arm, but fixed to a given cross section of the first robot arm. The control members are intended for entry and control of cabling. The first fastening device 4 is arranged to fasten the device to the turn disc and the first control member 40. The second fastening device 5 is arranged to be fixed to the second control member 50. The cabling 12 is arranged to be fixed to the turn disc. The turn disc has a centrally placed cavity, through which the cabling passes. The cabling is here arranged as a bundle of cables and lines. The cabling is connected to the turn disc and the control members, respectively, with a mutual orientation that is retained. The continuous cabling is arranged to run axially fixed, but longitudinally free in continuous openings arranged in the control members. The cabling is uniformly distributed so as to pass through the respective cross sections of both control members. The turn disc rotates about the sixth axis Ax6, which, without bending the wrist of the robot, coincides with the fourth axis Ax4. Thus, the cabling extends freely from the first control member via the second control member to a fixed connection in the first robot arm.

[0042] The torsionally rigid armouring in the form of a helical spring stabilizes the torsionally rigid flexible casing. The casing is made of, for example, polyurethane. The helical spring is made, for example, of metal or rigid plastic.

[0043] Figure 4 shows the above-mentioned embodiment of the invention comprising a casing 3 and continuous cabling 12. The first control member 50 is arranged at one end of the casing inside the first fastening device 4 and the second control member 40 is arranged inside the second fastening device 5 at the other end of the casing.

[0044] Figure 5 shows an industrial robot comprising two devices for controlling cabling according to a preferred embodiment of the invention. The first device is mounted to the turn disc 108 and divides the rotational movement about the sixth axis Ax6 and the bending movement about the fifth axis Ax5. The first device is mounted to the foot 100 which supports a stand 101 and divides the rotational movement about the first Ax1 and the bending movement about the second axis Ax2.

[0045] The invention is not limited to the embodiment shown but a person skilled in the art may, of course, modify it in several ways within the scope of the invention as defined in the claims. Thus, in a further embodiment, a casing of extra flexible materials is utilized, such as nylon, which has a certain resilience with regard to the rotation from one end of the casing to the other. This is utilized in applications where high precision is not necessary, but where still a considerable torque must be transmitted. An additional helical spring, with a helix angle opposite to that of the armoured helical spring, may also be utilized as a casing. The casing may also be arranged as a netting. The armouring may also include closed rings, which are not connected to each other.

[0046] The areas of application are in processes comprising welding, such as arc welding and spot welding, as well as machining, casting and sorting.

Claims

1. A device in an industrial robot for controlling cabling (12), comprising a plurality of cores, which is pulled through a first and a second robot part (100, 101, 103, 105, 104, 106, 107, 108), said robot parts being movably arranged for both rotation and bending relative to one another, said device also comprising a casing (3a) surrounding the cabling, **characterized in that** the device comprises a first control member (50) arranged at one end of the casing, a second control member (40) arranged at the other end of the casing, said control members being designned to fix the cores included in the cabling in a radial direction, that an armouring (3b) in the casing between the control members is adapted to essentially retain the cross section of the casing upon relative movement of the robot parts, and that the casing and the armouring are arranged, during relative movement of the robot parts, to cooperate for converting a rotation of the first control member into an essentially synchronous rotation of the second control member so that the cores extending through the control members and the casing are subjected to bending only.

2. A device according to claim 1, wherein said armouring comprises a helical spring.

3. A device according to any of the preceding claims, wherein the helical spring is cast inside the flexible casing.

4. A device according to any of claims 1-3, wherein the rotation is transmitted by means of shear forces.

5. A device according to any of claims 1-4, wherein said first robot part comprises a turn disc (108).

6. A device according to any of claims 1-4, wherein said first robot part comprises a foot (100).

7. A device according to any of claims 1-6, wherein said control members are detachably arranged.

8. A robot wrist, **characterized in that** the robot wrist comprises a device according to any of claims 1-7.

9. A robot arm, **characterized in that** the robot arm comprises a device according to any of claims 1-7.

10. An industrial robot, **characterized in that** the industrial robot comprises a device according to any of claims 1-8 and cabling housed in the device.

11. A method in an industrial robot for controlling cabling (12), comprising a plurality of cores, which is pulled through a first and a second robot part (100, 101, 103, 105, 104, 106, 107, 108), said robot parts being movably arranged for both rotation and bending relative to one another, and wherein the robot comprises a device comprising a casing (3a) through which the cabling is arranged to extend between the robot parts, **characterized in that** a first control member (50) is brought to fix the cores in a radial direction at one end of the casing, a second control member (40) is brought to fix the cores in a radial direction at the other end of the casing, that the casing is provided with armouring (3b) designed to essentially retain the cross section of the casing upon relative movement of the robot parts, and that the casing and the armouring are brought simultaneously to convert a rotation, included in the movement, of the first control member into an essentially synchronous rotation of the second control member, that the casing and the armouring during said rotation are brought to permit a bending, included in the movement, of the device, whereby the cores extending through the control members and the casing are brought to be subjected only to bending during relative movement of the robot parts.

12. A method according to the preceding claims, wherein said armouring is adapted to comprise a helical spring.

13. A method according to any of claims 11-12, wherein the helical spring is arranged to be cast into the flexible casing.

14. A method according to any of claims 11-13, wherein the rotation is transmitted by means of shear forces.

15. A method according to any of claims 11-14, wherein the first robot part is adapted to comprise a turn disc (108).

16. A method according to any of claims 11-14, wherein said first robot part is adapted to comprise a foot.

17. A method according to any of claims 11-16, wherein said control members are arranged to be detachable.

18. Use of a device according to any of claims 1-8, or a method according to any of claims 12-19, in an industrial robot, such as a torque transmitter.

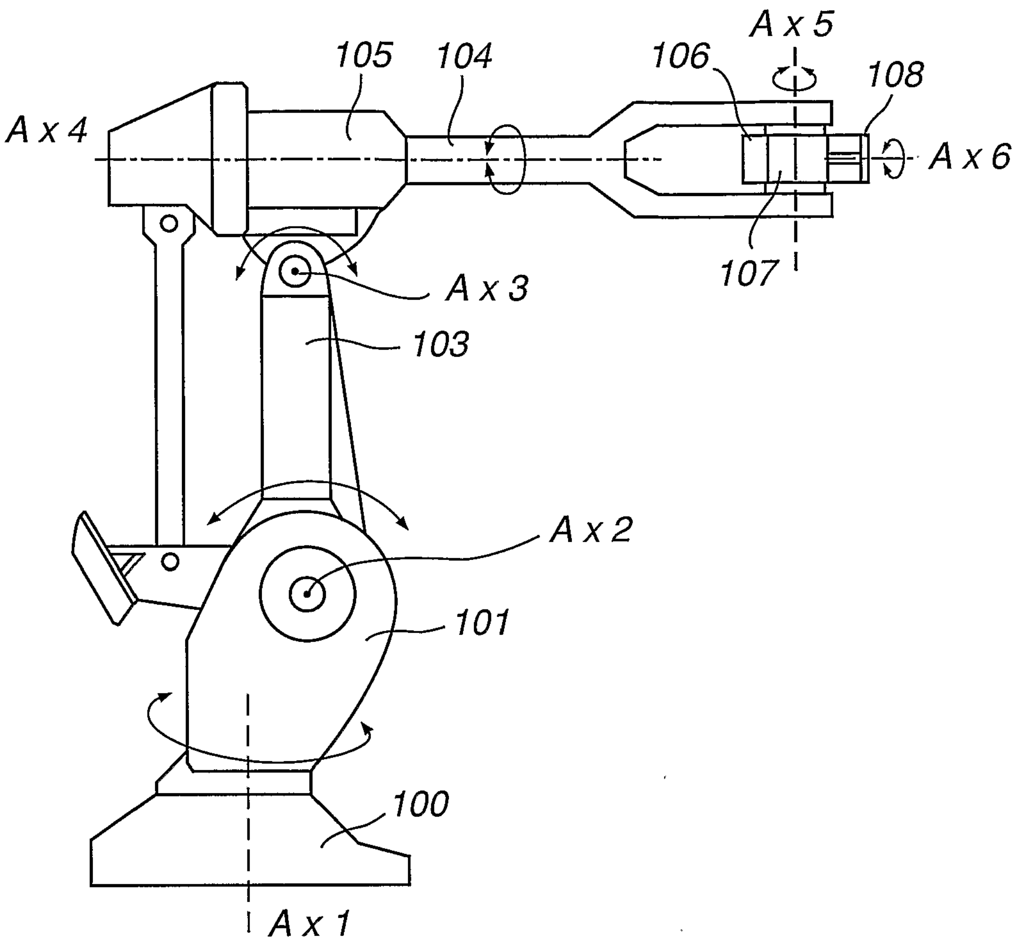


Fig. 1

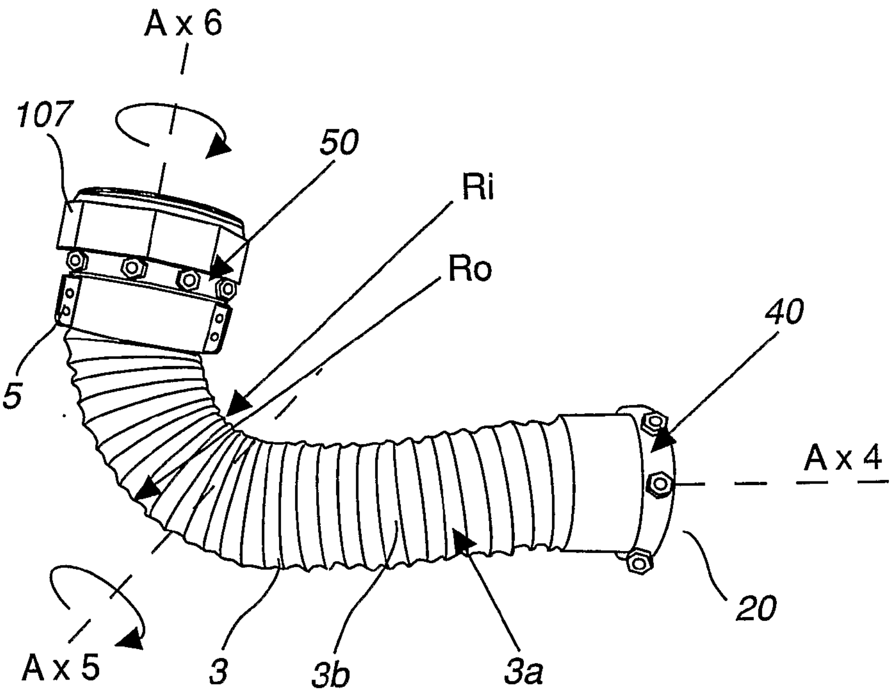


Fig. 2

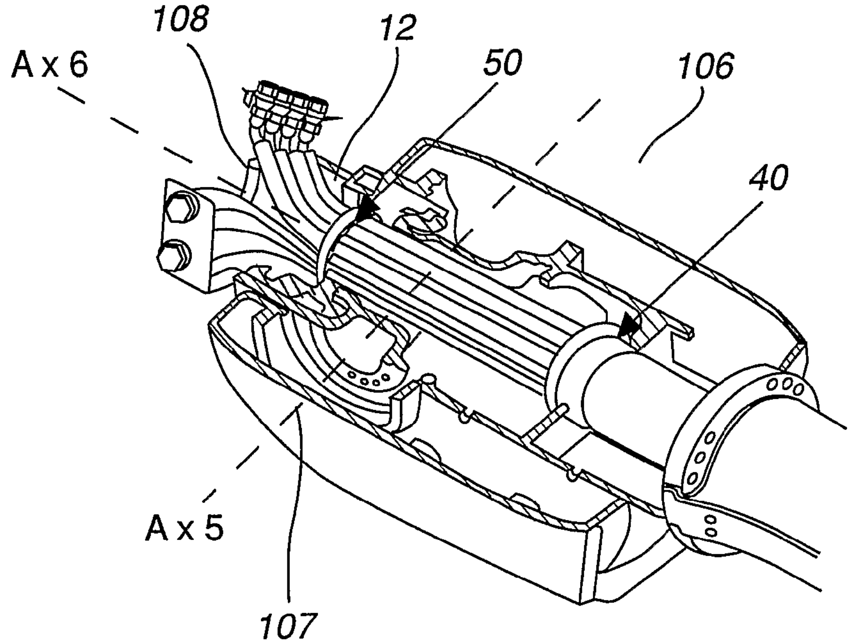


Fig. 3

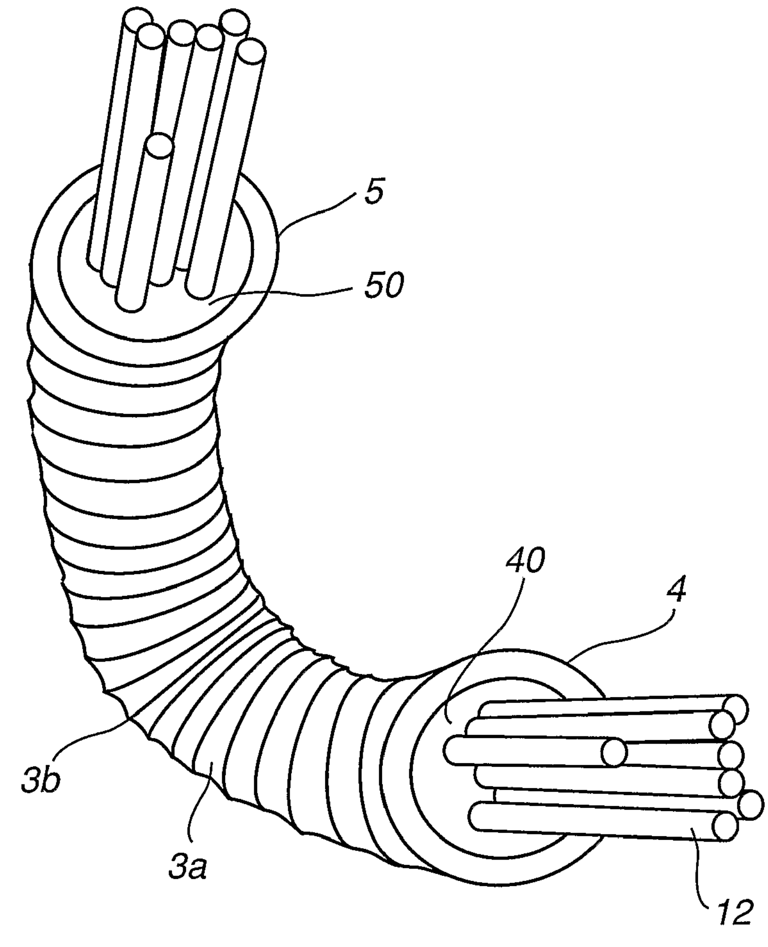
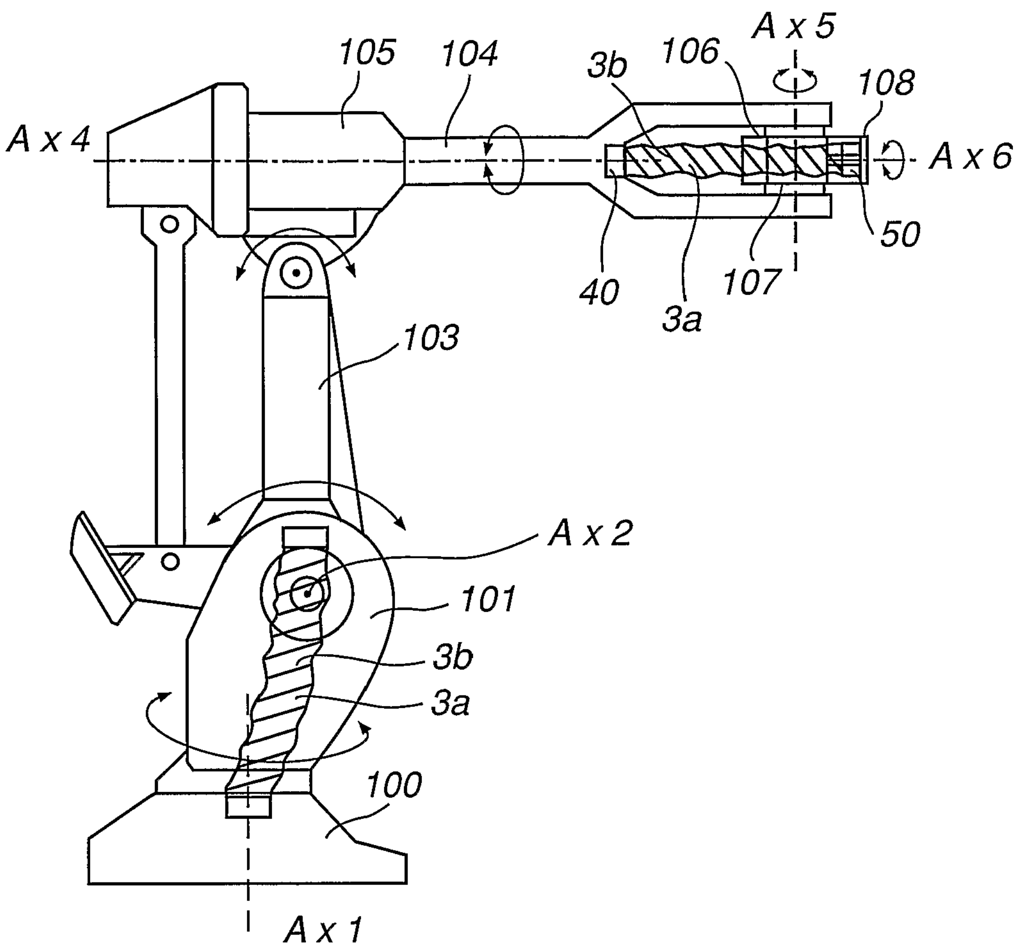


Fig. 4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A x 1

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 08 17 0427

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 6 288 512 B1 (BERNINGER ALWIN [DE] ET AL) 11 September 2001 (2001-09-11) * the whole document * -----	1-18	INV. B25J19/00
A	US 2001/052564 A1 (KARLINGER STEFAN [DE] STEFAN KARLINGER [DE]) 20 December 2001 (2001-12-20) * the whole document * -----	1-18	
A	EP 0 756 918 A1 (KOBE STEEL LTD [JP] KAWASAKI HEAVY IND LTD [JP]) 5 February 1997 (1997-02-05) * the whole document * -----	1-18	

TECHNICAL FIELDS SEARCHED (IPC)
B25J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	25 January 2010	Mingrino, Alessandra

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CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 17 0427

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25-01-2010

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6288512 B1	11-09-2001	DE 19817605 A1	21-10-1999
		EP 0950478 A2	20-10-1999
US 2001052564 A1	20-12-2001	EP 1163986 A2	19-12-2001
EP 0756918 A1	05-02-1997	CA 2188303 A1	29-08-1996
		DE 69617825 D1	24-01-2002
		DE 69617825 T2	27-06-2002
		ES 2164866 T3	01-03-2002
		JP 2746543 B2	06-05-1998
		JP 8229874 A	10-09-1996
		WO 9626045 A1	29-08-1996
		US 5816108 A	06-10-1998

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 0037224 A **[0008]**
- US 4499784 A **[0009]**